Cloud Computing

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Everyone is Talking About Cloud Computing

Software as a Service

Platform as a Service

Storage as a Service

Grid Computing

Database as a Service

Virtualization

Utility Computing

Application Hosting

Infrastructure as a Service

IDC on Cloud Computing:

"This is about the IT industry's new model for the next 20 years."

Vernon Turner, head of enterprise infrastructure, consumer and telecoms research.

"…reliable services delivered through data centers … accessible anywhere that has access to networking infrastructure.

The Cloud appears as a single point of access for all the computing needs…"

It's Not Just About Cheap Computing

Efficiency

Agility

Efficiency

Economics

- Pay as-you-go
- Op-ex vs. Cap-ex
- SLA
- Virtualization

Developer Centric

Rapid, self provisioning

Faster deployment

- Self service
- API-driven

Flexibility

- Standard services
- Elastic
- On demand
- Multi-tenant

Changing IT Relationships

Developers

- Why won't IT support this?
- Why can't I use the versions I want?
- Why can't I get better availability?
- How can I pay for what I need?
- How quickly can I get more servers?

Deployers

- Why do we have so many versions of everything?
- Where can I cut costs?
- How can I do finer grain provisioning?
- Where do we enforce security, regulation and audit?

Driving IT Agility

Current State

- Commercial software packages
- Relational data
- Management
- Server-scale

Trend

- Open source communities
- Unstructured, rich data
- Analytics
- Network data center-scale

All Clouds Share Key Traits

One Service Fits All

Virtualized Physical Resources

Self Provisioning

Elasticity

Pay Per Use

Programmatic Control

Layers

Business Models

Application Domains

BUT clouds can also be quite different

Cloud Dynamics – Evolves like the Network & Internet

- **<u>Just like the network,</u>** will get availability through redundancy and multiple providers

- **<u>Just like the network,</u>** will need common open standards and open source to provide redundancy to meet SLAs

- **<u>Just like the network,</u>** will have:

    - Private (LAN)

    - Mixed (WAN)

    - Public (Internet / DMZ)

- **<u>Just like the network,</u>** will need encryption and trust to enable it

- **<u>Just like the network,</u>** will need monitoring and security management

Types of Cloud Computing

Cloud Storage

- Encrypted on the way out, Decrypted on the way in.
- Many different SLAs and types

Application Cloud

- Encrypted communication
- Application server threads
- Stateless (most common) and Stateful

Infrastructure VM Cloud

- Encrypted Communication
- Windows, Linux, Solaris OS Images
- Full Applications, Virtual Servers, Virtual Desktops (Stateless clients)

Cloud Computing Layers

Software as a Service

Applications offered on-demand over
the network (salesforce.com)

Platform as a Service

Developer platform with built-in services
(Google App Engine, Microsoft Azure Platform)

Infrastructure as a Service

Basic storage and compute capabilities offered
as a service (Amazon web services, Microsoft's
Cloud Infrastructure Services, Mosso)

Business Models

Public	Private	Hybrid
You don't know who else is on the same server, network or disk that you are	You own the server, network and disk, and decide who gets to run on it with you	You own some parts and are sharing some parts, though in a controlled way

Application Domains

HPC

Medical

Intelligence

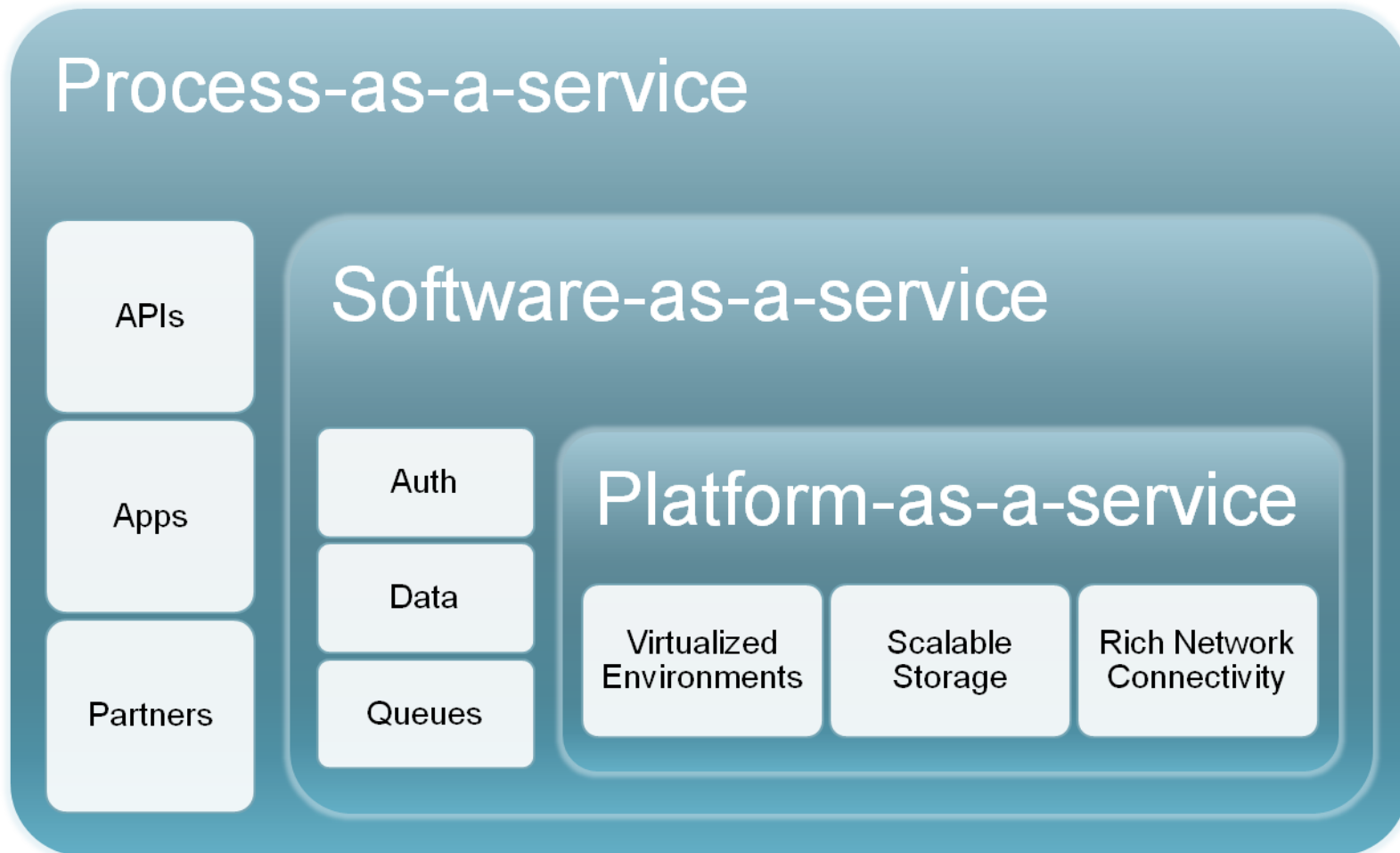Finance

Analytics

Web

Domains Drive Differences
in Hardware and Software Architecture

The Cloud - Under the Hood

Process-as-a-service

- APIs
- Apps
- Partners

Software-as-a-service

- Auth
- Data
- Queues

Platform-as-a-service

- Virtualized Environments
- Scalable Storage
- Rich Network Connectivity

Cloud Platforms, Compared

	AWS	AppEngine	Sun Cloud
Storage	S3, EBS	SimpleStorageAPI	Luster
Database	SimpleDB	CouchDB	MySQL
Queue	SQS	--	JavaSMQ
Virtualization	EC2 (Xen)	--	xVM OpsCenter
Framework	--	Django	JCAPS
User Accounts	--	Google Accounts	IDM Open SSO
Search	--	Google Search	SOLR+Lucene
Desktop	--	GoogleDocs?	SSR, VB, ODF
CDN/Cache	CloudFront		Varnish

Cloud Dynamics

Cloud as "Bow-Wave of Change"

Virtualization

Social Networks

Mashups, DIY Tools

Exponential Change

 Tech-savvy customers

  Tech-savvy employees

   Consumerization / Web 2.0

   Cloud Computing

   Public Infrastructure

   Global Collaboration

  Cultural Change

Security

Mobility

Green
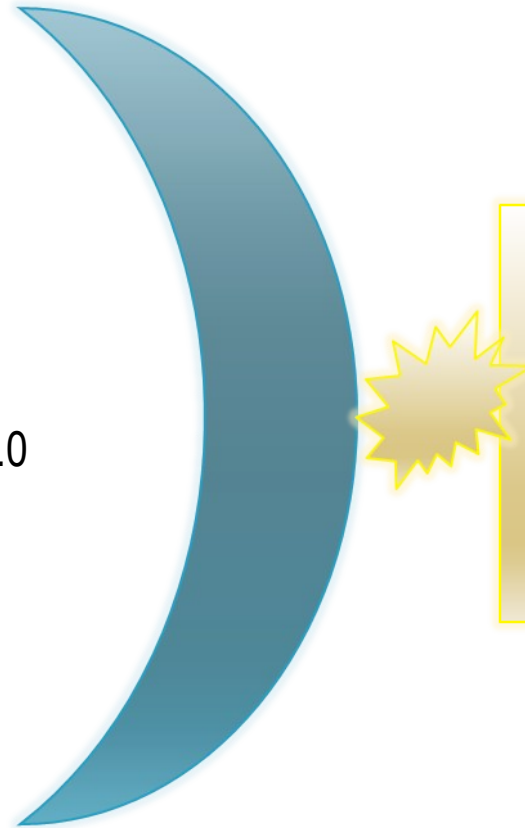
- Employees
- Missions / Data Products
- Business Operations
- Partners / Collaborators
- The Public

Source: Doug Neal, CSC

Cloud as "Evolution of Hosting"

Cloud (ISP 5.0)
Dynamic, Internet-optimized infrastructure for hosting your applications

ASP (ISP 4.0)
Hosted (traditionally designed) applications on servers at the Internet access point

Colo (ISP 3.0)
Racks for your equipment at the Internet access point

SaaS
Internet-based applications and services

ISP 2.0
Access to servers at the Internet access point

ISP 1.0
Provided access to the Internet (dial-up, ISDN, T1, T3)

Source: Forrester Research

Changing Software Economics

| 1998 | 2008 | ? |

New Data and Management Economics

Compute Trend | **Data (Storage) Trend**

New Analytics Emerge
(MapReduce, Hadoop...)

Semi-structured Data
(Mogile, Bigtable, HDFS...)

Google

hadoop

amazon web services™

HBASE

Architectural shift to the cloud
and HPC-style workloads

Greenplum
Open source, general
purpose datawarehouse

TERADATA.
Proprietary, dedicated
datawarehouse

ORACLE
OLTP is the
datawarehouse

Object Store

Distributed FS
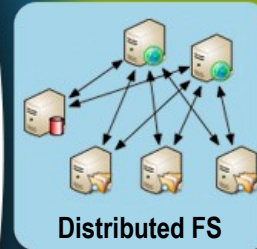
Unstructured Data

Semi-structured Database
ScaleDB, Big Table, SimpleDB hBase

Master/Slave

Master/Master

Federated/ Sharded
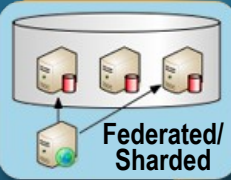
Structured Data

Emerging Cloud Deployment Patterns

Test and Development

Functional Offload
(Batch Processes – *TimesMachine*)

Functional Offload
(Storage – *SmugMug*)

Augmentation
(Temporary Load – *Animoto*)

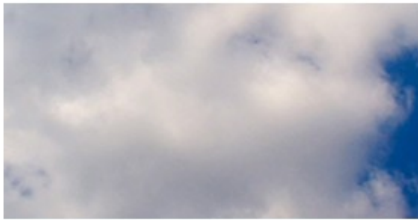## Web Service
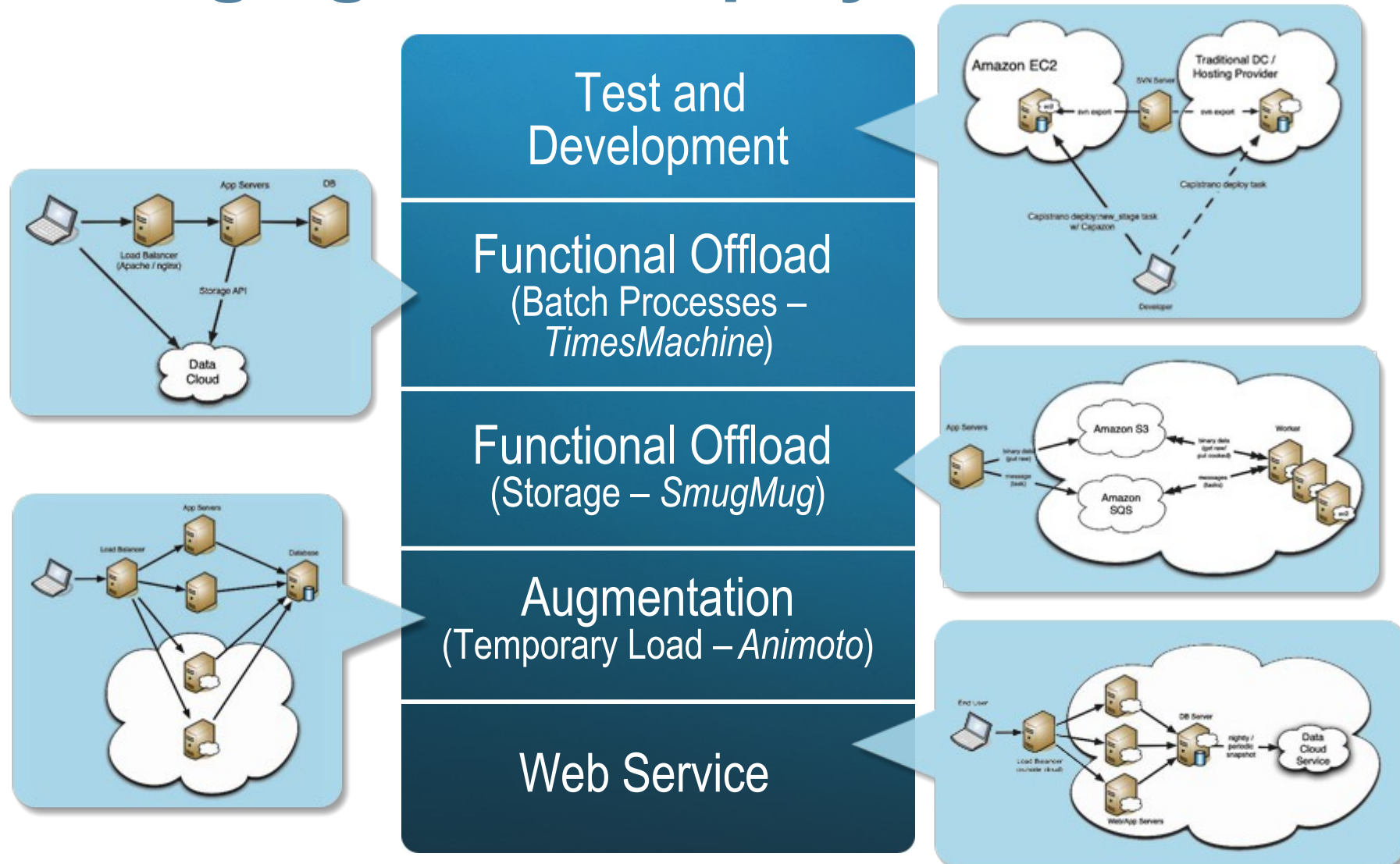
Cloud Ownership Models

USE the Cloud *(no datacenter ownerships)*	LEVERAGE the Cloud	BUILD My Own Internal Cloud	BE the Cloud
• Startup • SMB • Research projects	• Temporary on-demand load • Functional off- load	• Enterprise infrastructure grid • Drive internal IT economics • Standardized development environment/ services	• Redefine services • New business offerings • Hosting and operations partners • Software vendors

Concerns of Cloud Layers

IaaS	PaaS	SaaS	Developers/ Deployer Tradeoffs
• API-driven provisioning	• Reliability, load balancing, security subsumed • Data privacy, retention, recovery aspects	• User experience dominates • Loose coupling of other services	• Tradeoffs at each layer

Evolving Service Levels

Reliability, Availability, Serviceability (RAS)	Network Scale Service Level Demands (PIPE)
• Focused on state recovery • Low slew rate of demand or change	• Predictability: SLAs under high rate of change • Integrity: Security, compliance, correctness • Productivity: Agility and time to service • Efficiency: Throughput/$, work/watt

Examples

Introducing NASA NEBULA
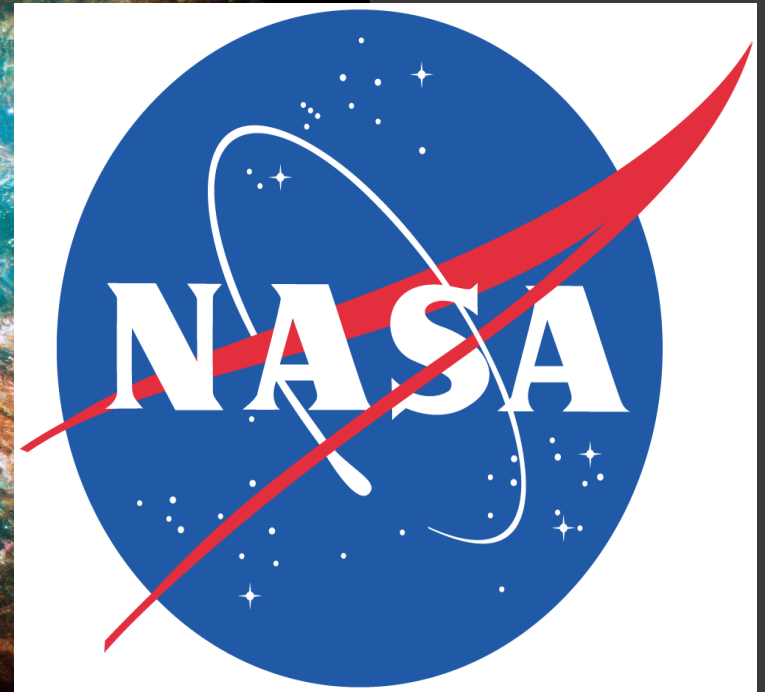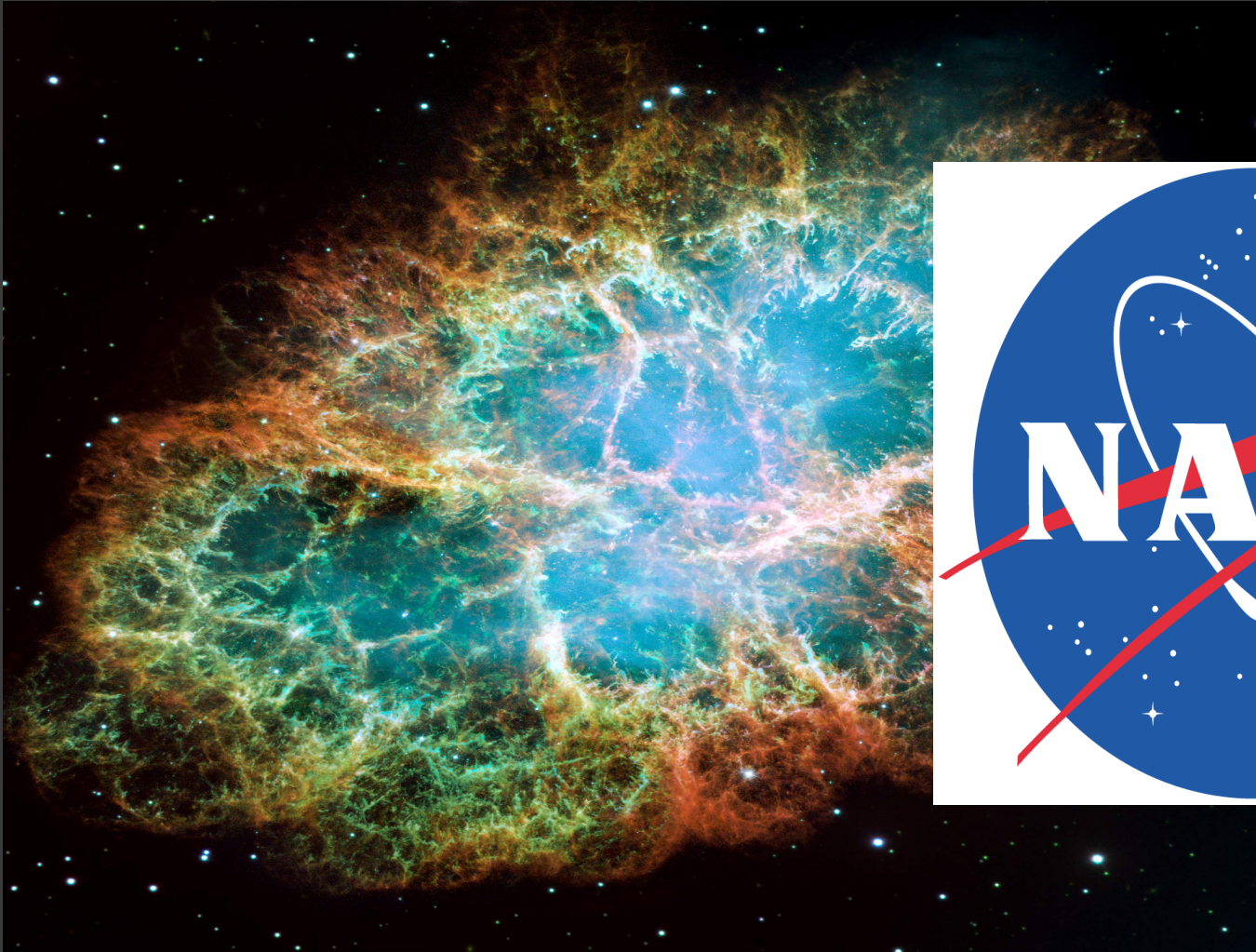
NEBULA – Built for Science

- Science-Class Cloud Computing
  - High CPU-to-Disk Ratio
- Built for Research
  - Fastest networks in the Agency
  - Massively Parallel, Loosely Coupled
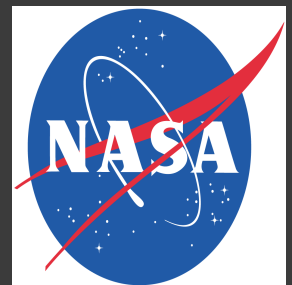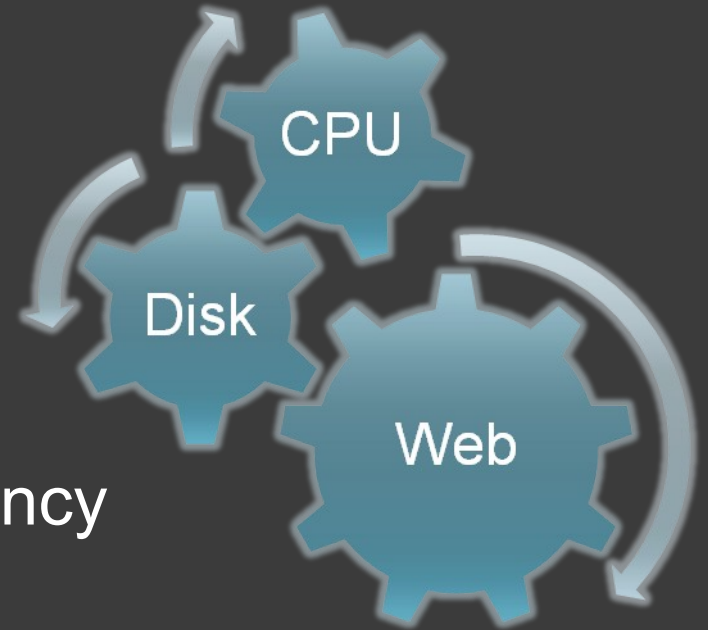
NEBULA – Built for Collaboration

- True Single-Sign-On, for the Public
- Enterprise Search, across the Cloud
- All Cloud apps live at apps.nasa.gov
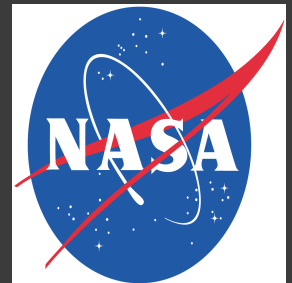
NEBULA – Built for the Web

- Friendly URLs
- Designed for Search Engines, RSS, and aggregation
- It's RSSable, Tweetable

- What if NASA was on the first page of Google results for the term 'Space'?

NEBULA – Built for Partners

- Your science partners can instantly connect from your NEBULA app, to their own research tasks within public Cloud Services (EC2, Azure, AppEngine)
- Your private fleet of Post-Docs can work on your data – at 10 cents an hour

NEBULA – Built for Partners
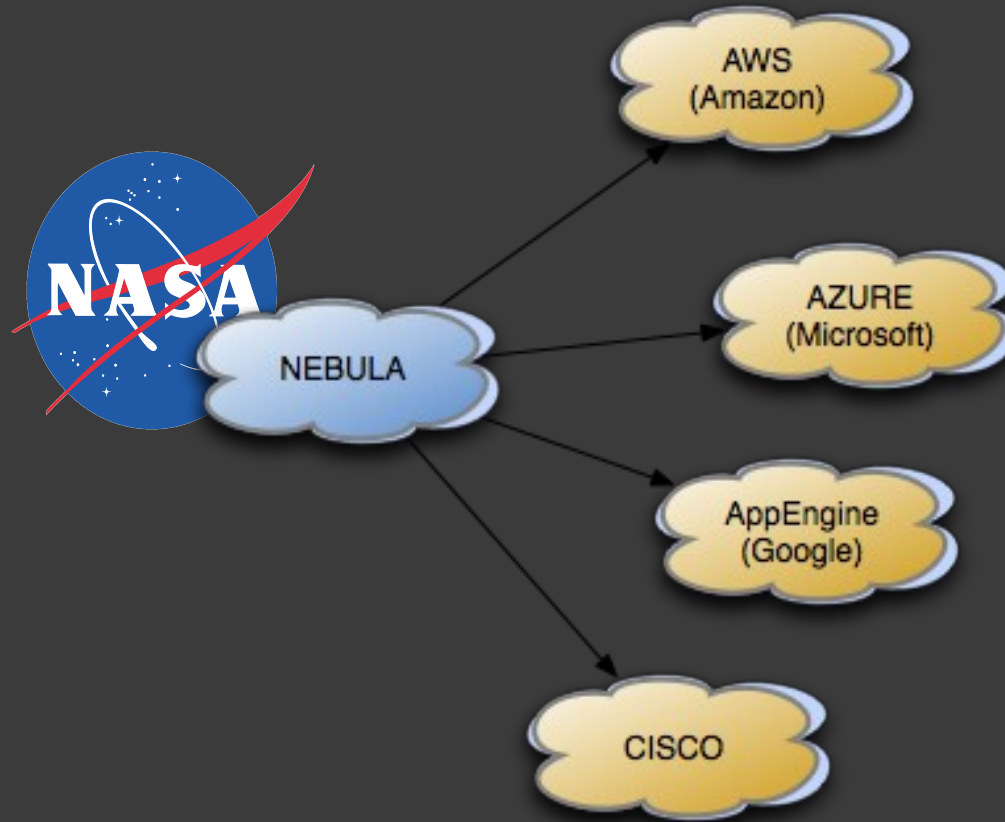
NEBULA – Built for Government

◉ Policy compliant for contributions

◉ Consolidated moderation interface

◉ Everything-compliant (PII, First Amendment, COPPA, Section 508, etc)

What *is* NEBULA?

Services			
Software	Hardware	Networks	Workflow

Cloud Platforms, Compared

	AWS	AppEngine	NASA Nebula
Storage	S3, EBS	SimpleStorage API	Luster
Database	SimpleDB	CouchDB	MySQL
Queue	SQS	--	RabbitMQ
Virtualization	EC2 (Xen)	--	Eucalyptus
Framework	--	Django	Django
User Accounts	--	Google Accounts	eAuthentication
Search	--	Google Search	SOLR+Lucene
Desktop	--	GoogleDocs?	--
CDN/Cache	CloudFront		Varnish

Application Time to Market

Current Web App Process	NEBULA Cloud Platform
Procure Server – 6-12 weeks	Procure VM – 60-120 seconds
Configure Server – 2-3 days	Included.
AWRS Filing – 2-3 days	Already done.
Set up Source Control – 2-3	Included.
Security Plan – 3 weeks, min.	Included.
SSL Certificates – 2-4 weeks.	Included.
Develop Terms of Use – 6	Included, for most collaboration.
eAuth Integration – 40 hours.	Included.
Develop Processes – 3-6	Basic moderation included.
Set up backups – 2-3 hours.	Included.
24,192,000 Seconds.	60-120 Seconds.

Cost Efficiencies

- No upfront capital expense
- Just-in-time capacity management
- 10^2 Cheaper (than what we do now)…

NEBULA – Designed for the Future

- "Open standards are critical to the growth of cloud computing and open source software has provided the foundation for many cloud computing implementations." – Barack Obama
- NEBULA is 100% Open Source

NEBULA – the way to Data.gov

- Best practices in moderation, open collaboration
- Open and Public APIs, everywhere
- Feeds (RSS, Atom) power mash-ups
- Open-source platform, apps, and data
- Fully transparent (we dogfood)

NASA NEBULA Timeline

- Under development since May 2008 (under codename NASA.NET)
- Now accepting a limited number of additional partners for Summer, '09
- Full Launch, 2010
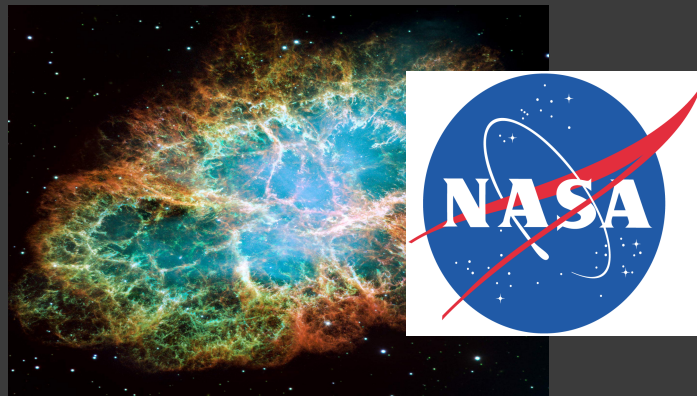
Sun's Vision

THE NETWORK
is the
Computer

Focusing on Network Transparent Computing Since 1984

Sun's Cloud Computing Strategy

How Sun Supports Different Approaches

- Public clouds

- Private clouds (owned and operated)
  - > Customers to run compatible services
  - > Patterns, tools, services, software components, data center design expertise, optimized systems and storage products

- Partner or hosted clouds
  - > Offer software for service providers and ISVs to reach additional customers and offer compatible variations

- Common elements
  - > Partnerships, communities and open approach

Next Steps

Getting Started

Developers

- Application inventory
  - Reliability at application or system level?
  - Languages, VMs, tools
- Developer inventory
  - Internal, communities, partners
- API inventory
  - Where can new abstractions be inserted?
  - What are deployment mechanisms?

Data

- Re-factor storage requirements
  - Move storage into the network
  - Structured, semi-structured, relational
- Analytics foundation
  - All (potential) sources of data
- Regulatory, security, privacy assessments
  - Access control, audit, assured destruction

How **SUN** can help

www.sun.com/cloud

- **Cloud Assessment Services**
- Architectural expertise
- Alignment of IT infrastructure goals to business driver
- Industry best practices and proven methodologies to create value-added solutions

- **Cloud Workshops**
- Gather business requirements
- Create a high level architecture

- **Specifics**
- Sun startup essentials
- Channel partner programs
- ISV programs
- Sun learning services

- **Feedback to Sun**
- Plans in development around a public cloud
- Open Solaris on EC2

The Network is ~~the~~ *YOUR* Computer

http://www.sun.com/cloud

Thank You...

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Sun Examples

Comprehensive **OPEN** Portfolio Delivering Customer Choice

	S E R V I C E S		
Developer Environment		NetBeans · The Apache Software Foundation · php · JRuby	eclipse · Microsoft Visual Studio
Database/ Storage Platform		MySQL · ZFS The Zettabyte File System · lustre · PostgreSQL	SYBASE · ORACLE · Microsoft Windows
Application Infrastructure		Java · Project Glassfish	bea Think liquid. · WebSphere · Microsoft Windows
Virtualization		xVM · VirtualBox	vmware · Microsoft Windows
Operating System		solaris · opensolaris	ubuntu · redhat. · suse · Microsoft Windows
Systems Servers Storage Networking		Sun microsystems · STORAGETEK	FUJITSU · IBM · DELL · hp
Microprocessor		OpenSPARC · AMD 64 Opteron · intel · ULTRASPARC	

Sun VirtualizationSolutions

- **DESKTOP TO DATACENTER**
innovation – highly integrated to increase efficiencies, security and performance

- **CHOICE**
in virtualization technologies + management
of your heterogeneous environments

- Virtualization **BUILT-IN**
and freely available

- **PROVEN EXPERTISE**
to design, implement, optimize and manage enterprise quality dynamic datacenters

Sun Open Storage

Bringing Simplicity to Cloud Storage

Open Storage and Archive

- Lower costs with general purpose systems and Open Software

- Seamless integration with existing environments

- Open architectures will free users from vendor lock-in

- Simple data administration

- Storage analytics provide sophisticated, real-time visualization

DTrace

ZFS
The Zettabyte File System

Dynamic scale with flexible building blocks

Superior performance

Manage more for less

NY Times: TimesMachine

- Massive data archives
  - > Every newspaper from 1851 to 1922
  - > http://timesmachine.nytimes.com

- Utilizes Amazon Web Services (public cloud) and Hadoop (OpenSolaris)

- 405,000 very large TIFF images, 3.3 million articles in SGML and 405,000 xml files -> converted to a more web-friendly 810,000 PNG images and 405,000 JavaScript files

- Created in 36 hours

Public Cloud Built on Open Source Innovation

- Amazon EC2 expanding customer choice with access to innovative opensource software
  - > Open Solaris – ZFS and Dynamic Tracing (DTrace)
  - > Sun/MySQL – Support for Linux
  - > Java
  - > Hadoop on Open Solaris
- Enhanced options – quick deployment

Using Sun Technology for Highly Efficient Scaling

JOYENT provides Cloud Computing infrastructure and services to Web 2.0 developers and Fortune 500 companies

Online Infrastructure provider offers hosted storage business with low-cost combined storage and server technology from Sun

- **Accelerators**
- Virtualized servers deployed within an ecosystem of the highest grade networking and routing fabric available
- Highly scalable on-demand infrastructure for running web sites, including rich web applications written in Ruby on Rails, PHP, Python and Java

- **Partnering with Sun**
- Built using OpenSolaris' Containers Virtualization Technology
- Joyent runs on Sun's CoolThreads and AMD Opteron-based servers running OpenSolaris
- Sun technology allows Joyent to give users and developers access to a great platform at a low price, and offers Web 2.0 developers a powerful environment where they can scale their applications

TACC: World's Top Supercomputer

Sun Fire X4500
- 72 Systems
- 1.7 petabytes
- 64.8 GB/sec total bandwidth

Sun Fire X4600
- 25 systems
- 800 cores

SunBlade 6048
- 3,936 blades
- 15,744K CPUs
- 62,976 cores
- 125 TB/RAM

Sun Data Center Switch 3456
- Dual redundant
- 110 TB/sec bisectional bandwidth

- The world's largest largest computing system in the world for open science research
- Sun Constellation Linux Cluster and Sun StorageTek Mass Storage Facility
- 579.4 Tflops peak performance